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Title: Migrating birds and carnivores introduce ticks and tick borne pathogens to Denmark – but are they also a public health risk?

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Introduction: Since the end of the ice age, spring migrating birds from Africa and Europe and autumn migrating birds from Northern Scandinavia have entered Denmark, and recently a small wave of long migrating carnivores have started arriving in Denmark from Central Europe. Theoretically, migrating birds could introduce new tick species as well as tick-associated pathogens to Denmark. These migrating animals may also carry ticks and pathogens which already exist in native tick populations in Denmark. The potential supplement of native ticks and existing pathogens to the established high density tick populations in Danish forest and nature areas can be expected to be of little practical importance. However, some of the infected ticks, introduced by migrating birds, may be deposited in private gardens and public parks that are otherwise not able to sustain a viable tick population. Migrating birds may therefore introduce a low level risk of tick borne infections to urban areas. Also the recent unexpected wave of long migrating golden jackals (*Canis aureus*) and grey wolves (*Canis lupus*), arriving at the Danish peninsula of Jutland, constitutes an emerging risk of introduction of especially *Dermacentor* spp ticks and their associated pathogens from Germany and Central Europe. Here, we present the results of screening migrating birds and a golden jackal for ticks as well as ticks collected by flagging in selected urban areas in Denmark. The collected ticks were screened for exotic tick species and 38 different tick borne pathogens. We show that the risk is not just theoretical and we suggest that these introductions may have a practical public health impact.

Material and methods: 1. Ticks collected from birds captured in mist nets at Danish bird ringing stations during the spring and autumn migration of 2016. 2. Ticks collected from a newly dead golden jackal from northern Jutland 2017. 3. Ticks collected in 2016 by flagging in 14 city parks in Copenhagen and 13 Copenhagen suburban recreational areas. All the ticks were tested individually for tick species, bacteria and parasites using Real-time PCR.

Results: We captured 807 birds during the spring and autumn migration. We found 180 larvae and nymphs of *Ixodes ricinus* ticks, but no exotic ticks were found on migrating birds. Of the 180 *I. ricinus* ticks, 61% were positive for at least one pathogen, but none of the pathogens were new to Denmark. One golden jackal from northern Jutland harbored 21 male *Dermacentor reticulatus* ticks, a tick species not previously recorded on Danish wild life. Eighteen of these ticks were positive for *Rickettsia raoultii*, a zoonotic pathogen not previously recorded in Scandinavia. We collected 641 ticks in 31 hours from urban and suburban areas, showing that questing ticks are abundant in Copenhagen urban and suburban parks. Female ticks were found in 19% of the sites. Nymphs were collected from 30% of the sites. Larvae were found at just 11% of the sites. Twenty percent of the urban nymphs were positive for *Borrelia* s.l.

Discussion/conclusions: Migrating birds transport ticks and pathogens to Denmark. Here we only found ticks and pathogens already present in Denmark. The additional supplement of infected ticks to Danish forests is expected to have little additional impact since the Danish tick abundance and pathogens prevalence in forest areas is already high. However, the observed relative scarcity of tick larvae in urban areas suggest that urban tick populations may not be viable populations and therefore partly be dependent on a constant influx of tick from other areas. Migrating birds may potentially be a significant source of infected ticks in urban areas. The high number of *I. ricinus* ticks found on migrating birds suggests that bird migration may also constitute a risk of introducing new tick species and pathogens. But this risk may have existed for thousands of years. The recent wave of migrating carnivores is however a new and very real risk of introducing infected *Dermacentor* spp ticks to Denmark.

References: Klitgaard K, Chriél M, Isbrand A, Jensen TK, Bødker R. Identification of *Dermacentor reticulatus* Ticks Carrying *Rickettsia raoultii* on Migrating Jackal, Denmark. Emerg Infect Dis. 2017;23(12):2072-2074. <https://dx.doi.org/10.3201/eid2312.170919>

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